Selknamella: a new agglutinated foraminiferal genus from the early Eocene southern high latitudes

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ABSTRACT: A new, unusual agglutinated foraminifera, *Selknamella basketi* n. gen., n. sp. is described from the Fuegian lower Eocene, Magallanes Basin, southernmost South America. It has a morphology and paleohabitat similar to those of the subfamily Remaneicinae Loeblich and Tappan 1964, particularly to the Holocene genera *Bruneica* Brönnimann, Keij and Zaninetti 1983, and *Remaneica* Rhumbler 1938: It has a low trochospirally coiled to patelliform small test; the first two or three embryonic chambers are globular and undivided; following chambers are semilunate-shaped from spiral view and mushroom-shaped from umbilical view, and subdivided by radial secondary septula. *Selknamella* n. gen. differs from all the organically-cemented Remaneicinae by the perforate rigid wall, completely calcareous in the initial chambers to very finely agglutinated in the last whorls. The new genus is the only case of calcareous cemented agglutinated foraminifera in the Cretaceous and Cenozoic of the Magallanes Basin, and is restricted to the early Eocene, coincident with the warmest time in the high southern latitudes.

INTRODUCTION

The Paleogene Río Claro Group, outcropping in the Fuegian Andes, southernmost South America, yielded foraminiferal assemblages of late Paleocene and Early Eocene age, a period that includes important events such as the early Eocene warming. These assemblages may provide clues to understand the effects of global events on the biotas at high southern latitudes, and to track the history of some foraminiferal taxa of probable Antarctic origin.

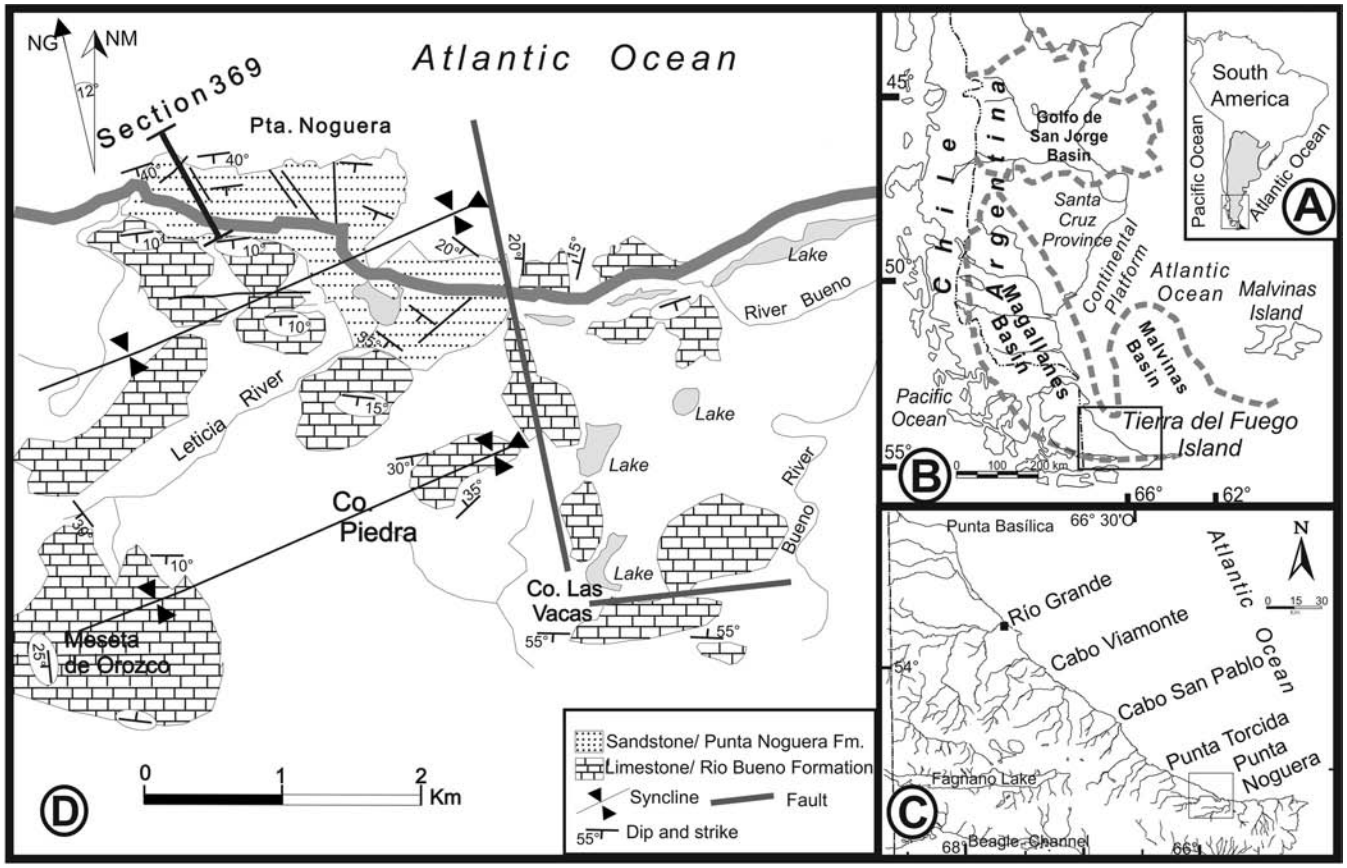
A major turnover in the benthic foraminiferal assemblages of the Río Claro Group occurs between the cosmopolitan assemblage of the late Paleocene La Barca Formation, and the more endemic assemblage of the early Eocene Punta Noguera Formation. The latter assemblage records the abrupt appearance of two typical post-Paleocene genera such as *Elphidium* Montfort 1808 and *Cribrorotalia* Hornibrook 1961. It also contains a new peculiar agglutinated foraminifera, *Selknamella basketi* n. gen., n. sp., described in this paper. This new taxon is the only case of calcareous cemented agglutinated foraminifera in the Cretaceous and Cenozoic of the Magallanes Basin. It also deserves attention as being clearly related to the Remaneicinae but of perforated calcareous cemented wall, providing a case study to analyze the systematics of agglutinated foraminifera.

Geologic setting and main features of the Paleogene foraminiferal assemblages of the Fuegian Andes

The Austral or Magallanes Basin, southernmost South America, contains Cretaceous and Cenozoic foraminiferal assemblages characteristic of Austral high latitudes, lacking larger foraminifera. Particularly, the marine Paleogene is exposed in a fairly complete but tectonically disturbed succession in the Fuegian Andes, the orogenic margin of the Basin. In the Fuegian Atlantic coast, the marine Paleogene is composed of three groups: the upper Paleocene-lower Eocene Río Claro Group, the upper middle-upper Eocene La Despedida Group, and the uppermost Eocene-Miocene Cabo Domingo Group.

The Río Claro Group represents a turbidite system, strongly dislocated, composed of three formations (Olivero and Malumián 2008). The upper Paleocene, organic-rich La Barca Formation, 200m thick, bears a poor agglutinated flysch-type assemblage, with only two restricted horizons preserving calcareous foraminifera. The lower horizon contains dominant buliminids, forming the *Buliminella karpatica* Assemblage, a mostly Midway-type assemblage, with few endemic species such as *Antarcticella* sp. and *Buliminella isabelleana* Camacho 1954 (Malumián and Caramés 2002). The upper horizon marks the last occurrence of *Stensioeina beccariiformis* (White 1928) in the region (Torres Carbonell et al. 2009). Both horizons are devoid of planktonic foraminifera.

Scarce agglutinated foraminifera including *Rzehakina minima* Cushman and Renz 1946 and *R. fissistomata* (Grzybowski 1901) characterize the subsequent Punta Noguera Formation, 380 m thick, of early Eocene age, in tectonic contact over La Barca Formation. Despite intensive sampling of several outcrops and the large amount of sample examined, calcareous microfossils were recovered from a single horizon at the formational type locality (text-figures 1, 2), which is of very difficult access, normally by helicopter. The horizon bears a moderately preserved assemblage composed only of benthic foraminifera, except for scarce chiloguembelinids (Malumián et al. 2009). It yielded the new agglutinated taxon *Selknamella basketi* n. gen., n. sp. The assemblage comprises, on one hand, species known to range up to the Paleocene elsewhere, such as *Alabamina creta* (Finlay 1940) and *Charltonina acutimarginata* (Finlay 1940). On the other hand, it comprises very abundant specimens of typical post-Paleocene shallow water genera such as *Cribrorotalia* and *Elphidium.* These are the oldest records of both genera, the former becoming the emblematic genus throughout the Patagonian Cenozoic. The assemblage includes



TEXT-FIGURE 1
Location map (modified after Olivero et al. 2002).

several Southern Hemisphere endemic benthic species, contrasting with the cosmopolitan late Paleocene assemblage of the La Barca Formation. This contrast reflects in high latitudes shallow environments the widely recognized turnover at the Paleocene/Eocene boundary in the deep ocean. It is the major turnover in the Cenozoic benthic foraminiferal assemblages of the Austral Basin.

The early Eocene age, close to the Paleocene/Eocene boundary, assigned to the Punta Noguera Formation by means of benthic foraminifera and serial planktonic foraminifera (Malumián et al. 2009), is consistent with its stratigraphical position and palynological content (Olivero et al. 2002).

The youngest unit of the Río Claro Group, the Punta Torcida Formation, late early Eocene in age, bears a rather diversified benthic assemblage with frequent endemic species such as *Antarcticella cecionii* (Cañón and Ernst 1974), and a low diversity planktonic assemblage, including some acarininids, *Globanomalina australiformis* (Jenkins 1966) and, in its uppermost member, abundant *Jenkinsina triseriata* (Terquem 1882).

A regional unconformity, which encompasses most of the lower middle Eocene, separates it from the following La Despedida Group, of late middle-late Eocene age and shallow-water setting.

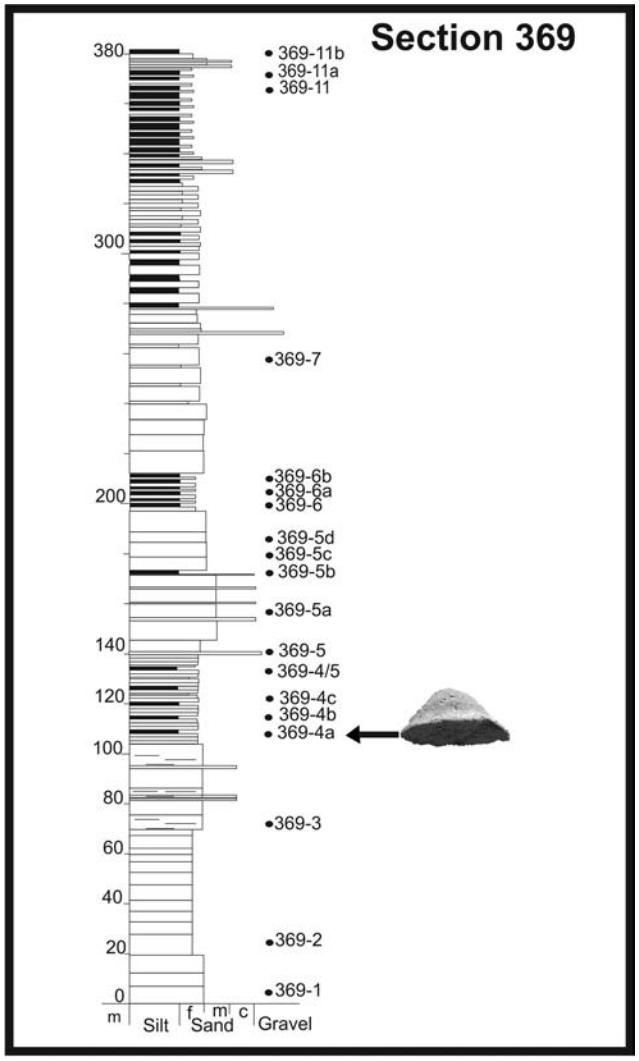
The agglutinated foraminiferal assemblages of the Austral Basin

The Austral or Magallanes retroarc basin possesses an almost complete Cretaceous-Paleogene marine clastic sequence, where assemblages of agglutinated foraminifera are common to dominant from the Aptian up to lower Miocene.

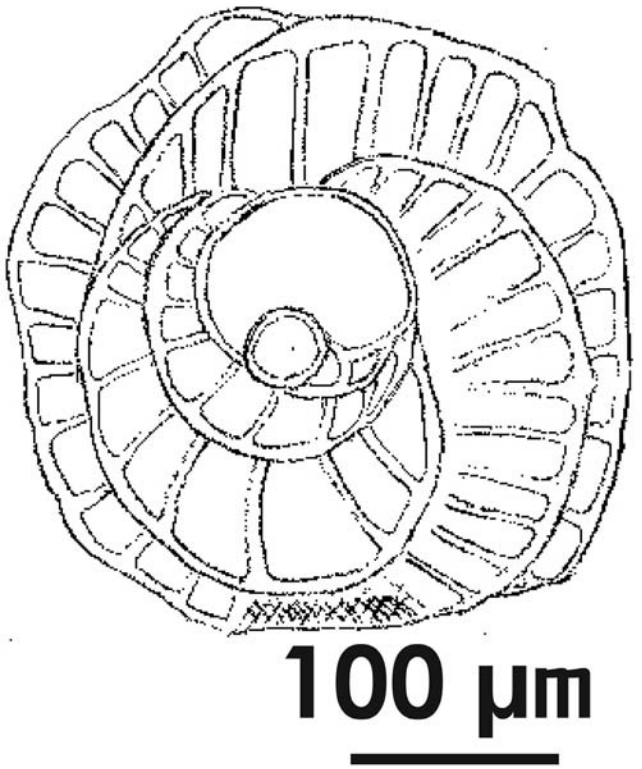
The distribution of these assemblages reflects the main tectonosedimentary regions: the active Andean margin comprises mostly flysch type cosmopolitan assemblages, towards the stable platforms mixed faunas of agglutinated and calcareous foraminifera occur, and to the borders low diversity assemblages of agglutinated foraminifera with apparent endemic forms are found (Malumián and Náñez 1990, 2012).

In the Hauterivian-Barremian, despite the good to exceptional preservation of calcareous foraminifera, agglutinated foraminifera are very scarce to absent probably due to a selective attack of bacteria on its organic cement in the dominant dysaerobic environments (Loeblich and Tappan 1989), and consequently, only one species, *Sculptobaculites goodlandensis* (Cushman and Alexander 1930), is locally common.

In the Albian-Cenomanian with the onset of oxygenated and open oceanic waters, mixed assemblages appear representing more stable environments, with cosmopolitan well known species of the *Marssonella* Assemblage such as *Spiroplectinata annectens* (Parker and Jones 1863), *S. complanata* (Reuss



TEXT-FIGURE 2
Stratigraphic section of the Punta Noguera Formation and location of the type sample of *Selknamella basketi* n. gen., n. sp. Modified after Olivero et al. (2002).



TEXT-FIGURE 3
Spiral view sketch of an oil immersed microspheric test broken at the periphery with the first two chambers without partitions.

1860), *Tritaxia gaultina* (Morozova 1948), *Marssonella oxycona* (Reuss 1860), and with abundant and conspicuous *Dorothia mordojovichi* Cañón and Ernst 1974, one of the few species apparently endemic to the basin. In marginal environments, the *Ammobaculites* Assemblage contains species common to the Great Artesian Basin, Australia.

A proxy indicator of Turonian age is given by *Spiroplectina ona* (Malumián and Masiuk 1976) in mixed assemblages, also widespread in the adjacent Malvinas subbasin.

The *Uvigerinammina jankoi* Assemblage is a well-developed flysch type assemblage recognized from the upper Santonian-lower Campanian in the southern Patagonian Andes. In the Fuegian platform setting, *Textularia juliana* (Malumián and Masiuk 1976) is the typical agglutinated species.

In the regressive facies, of very shallow and probably marshy environments, the so called *Textularia-Spiroplectammina* Assemblage, an almost monospecific assemblage of distorted biserial tests, is widespread nearly all over the basin in the Santa Cruz Province, from late Coniacian up to late Campanian. It is overlain by the low diversity assemblage of *Cribrostomoides* ex gr. *H. rugosus*, dominated by spiral and involute forms.

During the Late Campanian-Maastrichtian, agglutinated foraminifera are dominant in Andean regions. In the Southern Patagonian Andes, in shallow facies, the first agglutinated foraminifera of alveolar wall appear between *Hoplitoplacenticeras* (upper Campanian) and *Maorites* (Maastrichtian) horizons (Náñez and Malumián 2000). In the Fuegian Andes, the finely stratified black shales include horizons with monospecific assemblages of *Rzehakina lata* Cushman and Jarvis 1928, being this genus well represented up to the lower Eocene (Caramés and Malumián 2006).

The first extensive Atlantic transgression on the Patagonian platform occurred in the Maastrichtian and is represented by different agglutinated assemblages and endemic calcareous species (Náñez and Malumián 2008, Malumián and Náñez 2011). In the Magallanes Basin, *Ammobaculites* type assemblages are distributed on the Springhill platform, while flysch type assemblages are recorded in the Fuegian Andes, dominated by *Thalmannammina* cf. *turbinata* (Brady 1881), *Spiroplectammina spectabilis* (Grzybowski 1898), *Recurvoides* sp., *Gerochammina conversa* (Grzybowski 1901), and *Gaudryina healyi* Finlay 1939, (Olivero et al. 2002, Náñez and Malumián

2008, Malumián and Náñez 2011). The latter is a well-known species in the Austral regions.

The first appearance of *S. spectabilis* is a proxy for the base of the Maastrichtian, in assemblages where other age indicators are absent. This species is absolutely dominant, and almost the only agglutinated foraminifera found in the Fuegian organic-rich upper Paleocene La Barca Formation.

Earliest Eocene foraminiferal assemblages are only known from the Punta Noguera Formation, in the Fuegian Andes, and mark the appearance of *Selknamella,* n. gen.

In the Fuegian early Oligocene, the abrupt appearance of deep-water environments that remain up to the early Miocene is represented by assemblages of cosmopolitan agglutinated foraminifera under the calcite compensation depth.

In the earliest Miocene, a current of Antarctic corrosive water carried northwards the agglutinated *Spirosigmoilinella-Martinottiella* Assemblage, which occasionally includes dissolution resistant calcareous foraminifera of Antarctic origin such as *Antarcticella antarctica* (Leckie and Webb 1985) and *Ammoelphidiella* sp.

In synthesis, the agglutinated foraminifera from the Austral Basin reflect the paleogeographic position of the Basin in high Austral latitudes, with the virtual absence of larger forms. In this framework, *Selknamella basketi*, n. gen., n. sp., is relevant for being the only case of cemented calcareous perforate agglutinated foraminifera in the Magallanes Basin, which could be interpreted as the manifestation of the warming in the lower Eocene at high southern latitudes and the accentuated endemism resulting after the Paleocene/Eocene turnover.

TAXONOMY

Order FORAMINIFERIDA Eichwald 1830
Subfamily REMANEICINAE Loeblich and Tappan 1964

This subfamily, under the systematics of Mikhalevich (2004), is not confined to organic cemented non-perforate tests, but also includes calcareous cemented and perforate rigid agglutinated tests.

Genus ***Selknamella*** Malumián, Náñez, Jannou and Arenillas **n. gen.**
Type species: *Selknamella basketi* n. sp.

Diagnosis: A genus of the Remaneicinae with cemented calcareous perforated walls.

Description: Low trochospirally coiled to patelliform small test, subpolygonal to subcircular in outline. Rigid wall, completely calcareous in the initial chambers to very finely agglutinated in the last whorls. It bears scattered perforations, larger on the umbilical side (diameter: 3.75–5µm) and smaller and more abundant on the spiral side (2.5–3.35µm). The first two or three chambers are globular and undivided; subsequent chambers are semilunate from spiral view, mushroom-shaped from umbilical view, and partially subdivided by radial secondary septula. The interiomarginal aperture is situated at the end of a median umbilically directed scarcely perforate projection.

Etymology: From *Selknam*, an indigenous tribe from Tierra del Fuego Island, plus *ella*, feminine Greek diminutive.

Occurrence: Lower Eocene, Punta Noguera Formation, Tierra del Fuego Island.

Remarks: The genus *Selknamella* has a general morphology resembling that of the genus *Bruneica* but it differs from all the

PLATE 1

Scale bars = 100µm otherwise indicated.
Selknamella basketi n. gen., n. sp. Figure 2, holotype; figures 1, 3-5, paratypes.

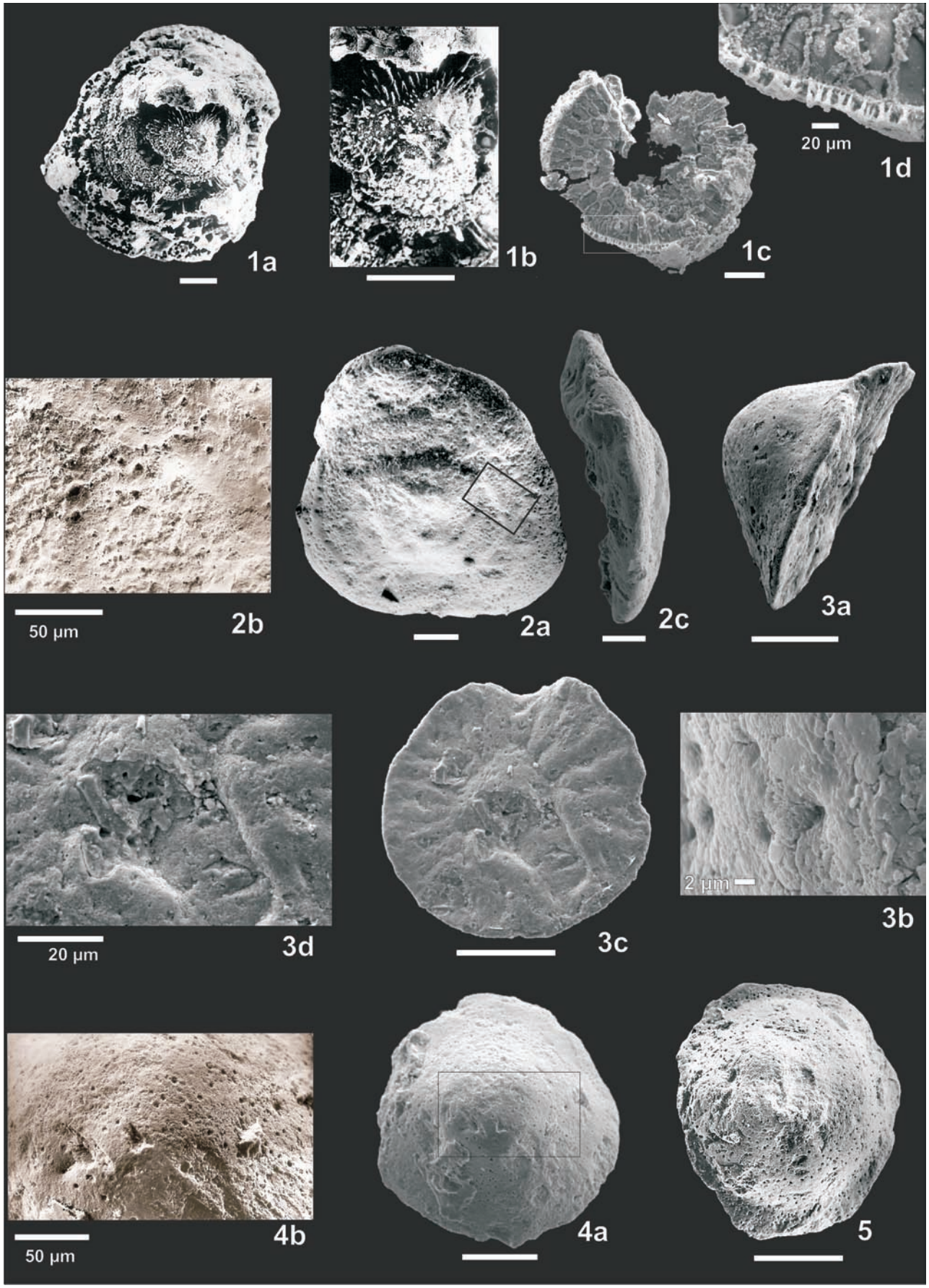
1 Spiral view of a deeply etched test with gypsum infilling of the first chambers and perforations, a, panoramic view; b, enlargement; c, apical view of a distal slice of the test, showing radial septula close to the periphery, and towards the umbilical region a more equidimensional mesh, and larger apertural vestibules (arrow) around the umbilicus; d, detail of infilling of the perforations.

2 a, Spiral view of the holotype, a well preserved test with polygonal outline and indistinct sutures; b, enlargement showing perforations; c, peripheral view.

3 Broken megalospheric test with elevated central spiral side. a, peripheral view; b, enlargement showing the distribution of perforations on the spiral side and diagenetic recrystallization of the calcareous cement and/or granular carbonate; c, umbilical view showing linear radial depressions reflecting radial secondary septula, sinuous chamber suture delimiting a petaloid area, and aperture; d, enlargement.

4 a, Spiral view of a conical test; b, enlargement showing the distribution of small perforations.

5 Spiral view of a broken megalospheric test showing the common preservation with the loss of more coarsely agglutinated whorls.


1a
1b
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5

Holocene organically-cemented Remaneicinae by the calcareous cemented rigid wall. Besides, it differs particularly from *Bruneica* by having only three to four chambers per whorl instead of five to seven, and the numerous chambers per whorl of *Remaneica*.

The apparent isomorphic genus *Conorbinella* Poroshina 1976, was included by Loeblich and Tappan (1985) in the *Conorbinella-Dictyopselloides-Dictyopsella* sequence of genera of the family Dictyopsellidae Brönnimann, Zaninetti and Whittaker 1983, the first only with radial beams, to the last with a developed subepidermal mesh. All the integrants of this sequence are linked and differ from *Selknamella* by the subdivision of the chambers by means of numerous radial beams of varied length intercalating shorter beams between longer ones, the different aperture, and a distinct Cretaceous range.

The similar general shape of the Holocene homeomorphs, particularly of the genus *Bruneica,* suggests an attached paleohabit in shallow water setting. A similar habit is supported by the frequency of tests partially damaged or with adherents on the umbilical side, the associated benthic foraminifera, marked by both the dominance of epifaunal morphotypes and attached tests, and the scarce planktonic foraminifera, only represented by small serial forms. This proposed paleohabit is also consistent with the glauconitic content of the Punta Noguera Formation that suggests the existence of hardgrounds (Malumián et al. 2009).

The other close homeomorph genus, *Abyssotherma* Brönnimann, Van Dover and Whittaker 1989, was described from a bathymetrically contrasting but thermally similar paleoenvironment, since it was found in the vicinity of deep-sea hydrothermal springs (Brönnimann, Van Dover and Whittaker 1989).

Selknamella basketi Malumián, Náñez, Jannou and Arenillas **n. sp.**
Plate 1, figures 1-5; plate 2, figures 1-4; text-figure 3

Crespinina sp. OLIVERO et al. 2002, p. 210.
Crespinina MALUMIÁN and NÁÑEZ 2002, p. 107.
"*Remaneica"* OLIVERO and MALUMIÁN 2008, p. 12.
'Remaneica' sp. nov. MALUMIÁN and JANNOU 2010, p. 351.

Diagnosis: As for the genus.

Description: Low trochospirally coiled to patelliform small test, spiral side gently convex to conical, umbilical side flat to concave. Subcircular to subpolygonal outline; periphery subrounded to acute. Spiral side with the first two or three chambers globular and undivided; subsequent chambers semilunate and subdivided by radial secondary septula, sutures smooth or slightly depressed, frequently indistinct, occasionally slightly limbate, three to four chambers in the last whorl. In umbilical view, chambers are mushroom-shaped, partially subdivided by radial septula. The umbilical tip of the chambers is undivided, slightly inflated, forming an umbilically directed projection open to the umbilical depression. Sutures on the umbilical side indistinct to slightly depressed, curved to sinuous, radial septula occasionally reflected by linear depressions on the umbilical wall. Umbilical surface is otherwise smooth, with scattered perforations, thin-walled, especially in the undivided, umbilical tip of the chambers.

Type locality and horizon. Punta Noguera Formation, Section 369, sample 369-4a (Text-figures 1, 2), Punta Noguera area, Tierra del Fuego Island, Argentina; 54º 10´ 07´´S, 65º14´03´´W.

Type material: Holotype deposited under reg. nº 2909, and paratypes under reg. no's 2010-2018, in the micropaleontology collection of the Servicio Geológico Minero Argentino.

Derivatio nominis: From Fuegia Basket, the adolescent Yaman indigenous taken as a hostage by Robert Fitz Roy, so that both Fuegian indigenous tribes: Selknam and Yaman are represented in the name.

Remarks: Intercameral sutures are usually indistinct, thus it is difficult to determine the chamber number with certainty; there are probably three to four chambers in the last whorl. Secondary septula vary in length and pattern; in some specimens, in umbilical view, the radial septula subdivide the peripheral part of the chambers, followed towards the umbilicus by more equidimensional compartments, and then by larger apertural vestibules around the umbilicus (Plate 1, fig. 1c). In some specimens, successive apertural projections are separated by petaloid or subcircular depressions (Plate 1, fig. 3c, d). Wall texture is highly variable; on the spiral side of high conical tests it is mostly smooth and perforated, with apparent loss of the more coarsely agglutinated younger chambers (e.g. Plate 1, fig. 5);

PLATE 2

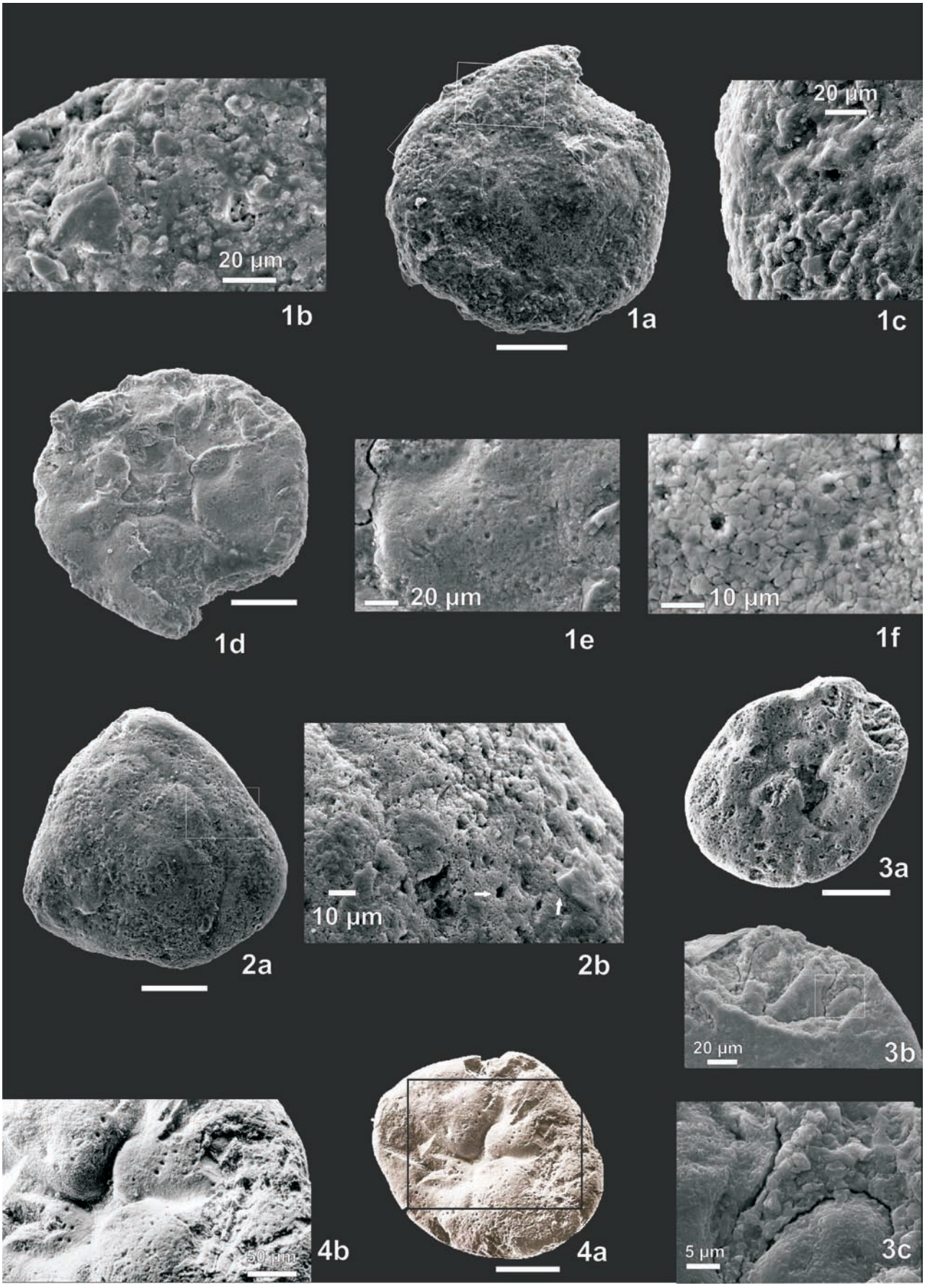
Scale bars =100µm otherwise indicated.
Selknamella basketi n. gen., n. sp. Figures 1-4, paratypes.

1 a, Spiral view of a test with the last whorl with obvious agglutinated wall with very fine foreign particles ca.10µm in diameter; b, c, enlargements; d, damaged umbilical side; e, f, enlargements showing smooth, calcareous wall and perforations on the umbilical side.

2 a, Spiral view of a juvenile and very low trochospiral test with subpolygonal outline; b, enlargement showing perforations and small foreign particles.

3 a, Umbilical view of a test broken in the last chamber; b, c, enlargement showing the septula and the fine agglutinated foreign particles in the septula and test walls.

4 a, Umbilical view showing scarce perforations on the median axially directed apertural projections, b, enlargement showing the apertures of successive chambers remaining open around the umbilicus.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4b
4a
5 µm
3c

spiral side of gently convex tests is commonly clearly agglutinated (e.g., Plate 2, fig. 1a), but also may be smooth and densely perforated (Plate 1, fig. 2); umbilical side is smooth, mostly calcareous, with scattered perforations. The umbilical side is frequently damaged, as well as the initial chambers on the spiral side, lacking or broken in several tests. The megalospheric tests have a prominent initial part more conical and thicker with respect to the following whorls; the microspheric tests are compressed and larger, the initial part with a thin wall that immersed in water allows details of embryonic chambers to be seen.

This species, known by the authors for more than a decade, was first assigned to the genus *Crespinina* Wade 1955. This generic assignment was due to the scarce material available at those times, mainly juvenile tests, or tests preserving only the more calcareous cemented initial whorls of non-agglutinated aspect, and the most evident agglutinated part broken.

DISCUSSION AND CONCLUSIONS

Significance of the new genus

The genus *Selknamella* n. gen. appears after the great turnover of the Paleocene/Eocene boundary, dramatically expressed at the latitude of Tierra del Fuego Island, in shallow-water assemblages (Malumián and Jannou 2010). The shallow-water Paleocene cosmopolitan Midway type assemblage is replaced by an early Eocene endemic austral assemblage. This turnover is mainly expressed, among the calcareous foraminifera, by the first record of the genera *Elphidium* and *Cribrorotalia* of the Elphidiidae. Both genera are considered of Antarctic origin, the former became cosmopolitan, and the latter remained restricted to austral latitudes and characterized the post-Paleocene shallow assemblages of Patagonia. At present, *Cribrorotalia* remains extant only in South American coasts.

Among the agglutinated foraminifera, the apparently endemic genus *Selknamella* n. gen. is very odd because it is the only agglutinated foraminifera with a calcareous cemented wall from the Magallanes Basin. Its occurrence would reflect the early Eocene warming in southern high latitudes, as calcareous cemented agglutinated foraminifera are mostly from tropical waters. It also manifests the accentuated endemism resulting after the Paleocene/Eocene turnover.

The genus *Selknamella* n. gen. raises questions on some of the systematics approaches to the agglutinated foraminifera. According to the most recent systematics proposals (*fide* Kaminski 2004), this new genus, despite the closely similar morphology, would not belong to the organically cemented and imperforate *Trochamminina* Saidova 1981, because it has a perforate calcareous cemented wall and consequently a firm and resistant test resulting from mineralization of the organic cement by calcium carbonate, and neither to the canaliculate *Textulariina* Delage and Herouard 1896, because its test gross morphology is uncommon in this suborder.

The canaliculate wall was considered of taxonomic importance to separate genera at the family level (Banner and Pereira 1981; Loeblich and Tappan 1985, 1987, 1989) and further to separate all the multichambered agglutinated foraminifera into canaliculate and non canaliculate groups. This separation is strongly questioned as a valid criterion at generic level (Mikhalevich and Peryt 2007) and the present case points to the dilemma.

The suprageneric location of this new genus thus depends whether the chemical composition and structure of the biogenic deposits of the test wall are regarded to be of major systematic importance or the gross morphology must be taken first into consideration.

According to its general morphological characteristics, we located *Selknamella* n. gen. in the Remaneicinae, a subfamily that was previously considered to be constituted only of genera of organic cemented agglutinated wall and consequently known only from the Holocene, considering the iterative evolution of canaliculate forms from noncanaliculate ones. The calcareous cemented wall of *Selknamella* n. gen. favored the preservation and fossilization of the tests extending the range of the subfamily from the Early Eocene. At present, taxa of this subfamily such as *Remaneica helgolandica* (Rhumbler 1938) are recorded all over the Argentinean continental platform (Boltovskoy et al. 1980). Since the Magallanes Basin remained at high paleolatitudes during the Paleogene, even after the opening of the Drake Passage, and has a rather complete Cenozoic sequence, it is a key area, near to Antarctica, to allow us better to understand the history of taxa of polar origin.

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